formed in the organism by the change of tissue is augmented, as well as the nitrogenous constituents of the excretions. (Bocker, Brit. and Foreign Med. Chir. Rev., Vol. XIV.)

Pfluger's views, in opposition to Voit's, assume that the proteid matter of the cell itself, "the organ-albumen," undergoes decomposition the more readily; and recently Schondorff (Archiv. f. d. gesammte physiologie, Band. liv, p. 420) has shown that the rate of decomposition of proteid matter in a tissue depends upon the nutritive condition of the cells themselves, and not upon albumen in the blood, lymph and other fluids bathing the cells. But though the organ-albumen may play the leading part in proteid metabolism of normal nutrition, the store-albumen would seem to be still the most vulnerable and apparent pabulum for the suddenly acquired microörganisms, the "contagium vivum." J. Meyer's investigations (Hoffman and Schwalbe's Jahresbencht, 1881) show that when the tissues are full of disintegration products the effect of water in increasing elimination is very marked, and that upon the wasting processes of the body the water exerts no influence.

Dr. H. C. Wood, quoting the above, adds "that while we can not by water produce tissue disintegration, we can by it wash out the retained products of tissue change."

In conclusion, I may add that the present generally accepted treatment of continued fevers, based upon scientific principles, is becoming more and more successful. A certain number of cases are unquestionably aborted by the cautious use of internal antiseptic remedies and calomel; most cases are benefited throughout their course by the ingestion of much water, and the greater percentage of all cases are successfully treated by the system of baths and hydrotherapy introduced by Brandt.

OBSERVATIONS ON NORMAL GROWTH AND DEVELOPMENT OF THE HUMAN BODY UNDER SYSTEMATIZED EXERCISE—READ IN THE SECTION ON PHYSIOLOGY, FIRST PAN-AMERICAN MEDICAL CONGRESS, WASHINGTON, D. C., SEPTEMBER 5–8, 1893.

By Henry G. Beyer, *Surgeon, U. S. Navy.*

Some of our best naturalists inform us that the first living things on this globe must have been microscopic monocellular organisms, inhabiting the surface of the great oceans and leading a free-swimming existence, like the protozoa, their direct descendants, of the present day. Nearly all of them furthermore agree, I think, that there could have been no departure whatever from this monocellularism of existence, no aggregation of cells to build up more complicated organisms could have taken place until some of these protozoa began to assume a sessile form of existence at the bottom of the ocean, whereby nutriment came to them in the current flowing by them, instead of their having to everlastingly hunt for it and thus expend all their available energy in this direction only.

The law of growth and development, in other words, depends on alternate rest and activity, and is one of the oldest and most fundamental in its relation to life in general. Where and however we may study life, whether it is during the embryonic conditions of the higher organisms, or in the adult conditions of both high and low forms of life, we recognize everywhere the existence of resting stages alternating with stages of activity.

Thus in the higher animals we find the corpuscles of blood and lymph ever active and in constant motion, microscopically small. According to the laws of growth they must remain so, but at the bottom of this sea of blood and lymph we find a number of sessile organs, aggregations of cells belonging to the same organism, and made possible only under the same law of alternate rest and activity.

Further reflection and observation have shown this great and fundamental natural law to be at the bottom not only of the evolution of all living forms at present existing, but we can observe it and study its influence in every individual living being.

It is consequently clear, then, that growth and development of the human body must be subject to the same unerring laws, and in order that they shall exert their most favorable influence on the formation of that body they must be duly observed and properly administered.

Exercise, alternating with rest, then, are the two most important factors with which scientific physical training will have to deal for the purpose of producing the highest results.

Speaking physiologically, there is no difference between the labor performed by the workman and that performed by the gymnast. Both the wood-chopper and the football player do muscular work. But the one has his exercise at his own hours and follows the laws of hygiene, diet, and rest, while the other does not do so, nor can he do so, and we can easily understand why exercise strengthens the one and wears out the other.

Neither does it make any difference to the contracting muscle whether it is made to contract according to the Swedish system or the German system, or even the American system, as long as it is caused to contract thoroughly and energetically and is allowed to rest after contraction, it will develop and grow in spite of any system.

For a number of years past a system of anthropometric measurements has been introduced into some of our best schools and colleges for the avowed purpose of watching with more accuracy and scientific exactness than heretofore the processes of growth and development of the rising generation of Americans as they march through the college gymnasia of these respective institutions.

The highest credit and praise are due to the pioneers in this laborious undertaking. The large number of finely equipped gymnasia that have sprung up everywhere like magic must be looked upon as the direct results of their most excellent missionary work in the cause of physical education.

But, although growth and development are primarily physiological subjects, and therefore should greatly interest physiologists, very little interest has, so far at least, come from that direction.

Most of the papers that have appeared, ever since the time of the introduction of these measurements, are most decidedly of more anatomical and anthropometrical interest than of physiological value, and, so far at least, anthropometry has been made an end rather than a means.

However, since we have at last succeeded in discovering not only the typical and ideal man, but the woman also (models at Chicago Exhibition), there is some hope that the leaders in physical education may turn their talents to the much neglected physiological side of this question.

Indeed, a beginning has already been made, and I have in my possession three papers of the utmost physiological importance as regards physical education.

The first of these parers is "The Growth of Children, Studied by Galton's Method of Percentile Grades," by H. P. Bowditch; the second is entitled "The Physical Basis of Precocity and Dullness," by W. T. Porter, and the third is "Observations on the Results of the Pedagogical Gymnastics of the Lung System," by Claës J. Enebuske.

The object I have in view in preparing this paper is partly for the purpose of inviting more interest in this subject on the part of physiologists, and partly, also, to add some observations of my own, made on fifty naval cadets, as ascertained by two successive measurements made at certain intervals, namely: The first measurement was taken in September, 1892, and the second in April, 1893, the time interval between the two measurements being, therefore, about six months.

From the whole number of measurements usually taken of each individual, only a few were selected for consideration here, since to discuss them all would rather detract from the few more important ones selected for our purpose, and would add nothing to the physiological value of the results that may be derived from them all.

These items are (1) the height, (2) the weight, (3) the lung capacity, and (4) the total strength. We will also take into consideration the vital index, the power index, the strength-weight index, and the vital strength-weight index, which form very important indices, introduced by Enebuske, and all deducible from the first four items.

As regards the nature of the gymnastic exercises which the cadets took during the interval of these measurements, I could not say that any one particular system of gymnastics was followed out to the exclusion of every other system. From the point of view of the physiologist there can be but one system, namely, that of common sense and judgment, having for its sole purpose the gradual, progressive, harmonious, and symmetrical development of the individual according to his needs and according to physiological laws, and in this process the instruments used are the subordinate means to the end, no matter to what particular system of gymnastics they may belong.

A brief outline, however, of these exercises seems called for. Thus, during the first month calisthenics, or free movements, were daily employed, and breath-

ing exercises were practiced on the different chest weights. During the second month dumb-bells, Indian clubs, and boxing were introduced. During the third month running, jumping, and vaulting were begun. During the fourth month rope-climbing, rope-jumping, horizontal and parallel bar exercises were done. After that the out-of-door drills began and the cadets only exercised in the gymnasium in rainy weather, some also doing special exercises prescribed for them in accordance with their special needs and requirements. This is, in brief, the course that was pursued. All had infantry drill, but none had any fencing, which is begun after the first year of their stay at the Academy.

The time devoted to gymnastic exercises was one hour per day, except Wednesday, making five hours per week in all, the remainder of the time, of course, being devoted to mental work with the usual intermissions for recreation common to all schools. The cadets are also taught dancing during the winter, and the weekly Saturday-night cadet hops continue throughout the academic year, not all the cadets, however, taking part.

It is, perhaps, but fair to state that the changes that are recorded in the following table as having taken place in the cadets are not and can not be looked upon as strictly comparative, nor as due to the gymnastic exercises alone, for in order to make them strictly comparative it would require the records of fifty other cadets of the same age and living under the same conditions, that had not taken this exercise, and, besides, there were other exercises taken outside the gymnasium and belonging to the Academy curriculum not strictly to be classified as gymnasium exercises.

We will begin, then, first with the consideration of their height, and see what changes we can detect in that; also what possible standard we may derive from a larger number of cadets that had entered previously to 1892. The records of this Department place at my disposal so far 230 entries of cadets whose height was accurately measured and recorded upon their entry into the Naval Academy. Inasmuch as there exists no standard for admission to the Academy as regards height for a certain age, except that the candidate, regardless of his age, shall not measure less than 5 feet or 1,624 millimeters, that he shall be sound and not less than 15 years of age, it seemed promising of some interest to find out just how the average height of the entering naval cadet, under this plan, compared with that of other schools and colleges from which data for comparison are at hand, taking of course the age into consideration in making this comparison.

The following table shows the distribution of the 230 cadets as regards height in millimeters:

TABLE I.

Mm	No. of observations.	Mm.	No. of observations.
1,850	2	1,625	23
1,825	1	1,600	8
1,800	15	1,575	2
1,775	19	1,550	2
1,750	27	1,525	0
1,725	34	1,500	0
1,700	36	1,475	1
1,675	28		
1,650	32	Total.	230

The next table shows their heights arranged in percentile grades varying from 5 to 95 per cent as they compare with those of the Amherst students, aged 17 years, and those of the Boston schoolboys aged 16, 17, and 18 years, respectively. The average age of the 230 cadets is 18 years.

TABLE 2.

Average age.	No. of observations.	5	10	20	30	40	50	60	70	80	90	95	Average.	P. C.
		mm.	mm.	mm.	mm	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	
18	230	1,587	1,611	1,628	1,650	1,656	1,678	1,681	1,725	1,726	1,751	1,775	1,679	Cadet.
17	2,230	1,625	1,647	1,674	1,692	1,710	1,724	1,739	1,756	1,776	1,804	1,827	1,726	Amherst students.
18	65	1,602	1,627	1,653	1,666	1,681	1,696	1,710	1,725	1,749	1,788	1,802	1,684	Boston school boys.
17	128	1,567	1,591	1,630	1,653	1,669	1,686	1,705	1,729	1,746	1,780	1,801	1,684	Do.
16	233	1,544	1,573	1,607	1,634	1,655	1,677	1,692	1,707	1,722	1,756	1,783	1,665	Do.

This table would show that the height of the naval cadet is considerably below that of the Amherst student, as well as that of the Boston schoolboy at the same average age, and at the time of his entrance into the Naval Academy. The figures from the Amherst students were derived in part from Tables 5 and 7 of the anthropometric tables published by Prof. Hitchcock in 1892; the age was taken from Table 5 and the percentile grades from Table 7. The figures of the Boston schoolboys were obtained from Prof. H. P. Bowditch's work on "The Growth of Children, Studied by Galton's Method of Percentile Grades," published in 1891.

This comparison, however, is perhaps not perfectly fair, since the above two standards were compiled from part of our population noted for their height, while the cadets come from all parts of the country. They are, however, the only ones so far published, and consequently there was no choice in the matter of selection. The height of the average Yale student, according to Seaver's tables, at the age of 18 years, is given at 1,664^{mm}, and in accordance with this the average naval cadet would come out from 14 to 15^{mm}, or about three-fifths of an inch taller than the Yale student of the same age. It would, therefore, seem Yale College, being a larger school than Amherst, and deriving its students from a larger territory than the latter, the average height of the Yale student is lower and approaches more nearly the national average standard. As compared with the Boston schoolboys, the naval cadet of 18 years of age approaches more nearly the 16-year-old boy in height than the 17-year-old one. The 50 per centile grade of height calculated from the 230 cadets at an average age of 18 years is 1,678^{mm}, and the same grade of Boston schoolboys at an average of 16 years, is 1,677^{mm}, or 1 millimeter less than that, while the average height of the cadets is 1,679^{mm}, and that of the schoolboys 1,665 or 14^{mm}, less. The 18-year-old Boston schoolboy, measuring 1,695^{mm} in height, is therefore 16^{mm} in advance of the average height of the naval cadet, and the naval cadet is about 15^{mm} taller than the Yale student of the same age.

Heights will probably always form one of the most important indices in our calculation and judgment of the physical possibilities of the man. Long bones naturally imply the existence of long muscles to move them, and there seems to be more room in a large frame also for the circumferential growth of the muscles than there is about a small, contracted framework. A capacious thorax, furthermore, will contain a larger lung, implying a greater lung capacity than a smaller one.

In the adjoining two tables of the heights of the fifty cadets, under more especial consideration here, it will be noticed that each one of the two tables represents the measurements of twenty-five. Since this division of them is not merely accidental, but purposive and will appear throughout this paper, it is necessary at the outset to state how and upon what ground this division was made.

The principle in accordance with which the total number of cadets was divided is the amount of increase in total strength that took place in all between the first and second measurements.

Table A contains all those whose increase in total strength was 100 kilograms or less, and Table B contains all those whose increase in total strength was above 100 kilograms.

On comparing the two tables we will find that their various ages average about the same, namely 18 years. We find, also, that their increase in height is very nearly the same on the average, but the average height of those on Table A is 13^{mm} below that of Table B.

Table of heights.

A.

No.	Age.	Height (first measurement.)	Height (second measurement.)	Annual gain.	No.	Age.	Height (first measurement.)	Height (second measurement.)	Annual gain.
		mm.	*mm.*	*mm.*			*mm.*	*mm.*	*mm.*
1	16.0	1,663	1,683	20	15	16.7	1,758	1,785	27
2	16.8	1,652	1,659	7	16	20.3	1,618	1,620	2
3	17.3	1,710	1,723	13	17	19.3	1,748	1,750	2
4	18.0	1,730	1,736	6	18	18.8	1,800	1,806	6
5	17.6	1,719	1,721	2	19	19.0	1,730	1,740	10
6	18.5	1,735	1,735	0	20	19.0	1,818	1,820	2
7	19.6	1,775	1,779	4	21	17.3	1,650	1,658	8
8	19.9	1,682	1,688	6	22	17.5	1,766	1,766	0
9	17.0	1,753	1,760	7	23	17.5	1,645	1,649	4
10	18.2	1,688	1,700	12	24	18.0	1,718	1,733	15
11	20.1	1,742	1,742	0	25	16.1	1,780	1,784	4
12	15.3	1,656	1,694	38					
13	17.1	1,695	1,700	5	Averages	18.0	1.715	1,723	8
14	18.9	1,638	1,645	7					

B.

1	19.11	1,811	1,811	0	15	18.5	1,850	1,850	0
2	16.0	1,693	1,712	19	16	18.7	1,670	1,680	10
3	16.6	1,770	1,781	11	17	19.3	1,720	1,720	0
4	17.9	1,740	1,740	0	18	19.8	1,770	1,770	0
5	19.2	1,708	1,720	12	19	19.5	1,716	1,720	4
6	18.2	1,606	1,610	4	20	15.5	1,633	1,670	37
7	17.3	1,669	1,672	3	21	18.11	1,704	1,712	8
8	18.4	1,698	1,700	2	22	17.9	1,700	1,711	11
9	18.0	1,705	1,712	7	23	16.3	1,730	1,742	12
10	19.0	1,730	1,733	3	24	16.4	1,676	1,695	19
11	19.0	1,810	1,810	0	25	19.7	1,803	1,804	1
12	17.8	1,751	1,754	3					
13	16.7	1,754	1,754	0	Averages	18.0	1,728	1,735	7.3
14	16.3	1,786	1,792	6					

Now, the question might well be asked, is it a mere coincidence or is it of a certain significance that the members of Table B, who were slightly taller in the beginning than the members represented on Table A, had their total strength increased so much more than the members of Table A, all of them living under identical conditions?

This question will be more fully discussed in connection with the tables of total strength to be presented later on.

The average height, then, of the 50 cadets at the beginning, and as ascertained by the first measurement, is 1,721^{mm}, and toward the close of the six months, as ascertained by the second measurement, it is found to be 1,729^{mm}, showing an increase in the average height of 8^{mm}, or about one-third of an inch. At present there exists no standard of comparison of the annual or semiannual growth of boys at all ages. An approximation to such a standard of development in height and weight for the pupils of the Boston public schools has been published in the above-mentioned work of H. P. Bowditch for a period of from 5 to 17 years; but, inasmuch as Bowditch has shown that this increase is irregular and grows smaller the nearer the individual approaches to its destined maximum size, in order to fairly compare the growth of our cadets we ought to have a standard giving the increase in height above the age of 18 years, this being the average age with which we started. On looking over the tables of Yale students published by Seaver I find that the height given for students aged 18 years and 6 months, which period would exactly correspond to the average ages of our cadets at the time of the second measurement, is 1,687^{mm}, or 23^{mm} above the height given on the same tables for those of 18 years, and which is 1,664^{mm}. According to these tables, then, the semiannual increase in height from 18 to 18½ years would be 23^{mm}, or nearly 1 inch for Yale students.

On examining the table of ages of the students at Amherst College, published by Hitchcock, I find that the height given for students of 18 years and 19 years of age is exactly the same, namely, 1,733^{mm}, apparently indicating no growth at all during the period between 18 and 19 years.

Thus it must be admitted, until we have arrived at an exact standard of growth

from year to year for all ages up to the twenty-second year, it is impossible to state whether the average increase of 8mm ascertained for our cadets is above or below the amount that it shouldbe.

One thing, however, seems to be clearly established by our tables of comparison alone, and that is this: The average height of the 50 cadets that entered the Academy in the fall of 1892 being 1,721mm, it is 42mm, or 1⅝ of an inch higher than the average height of the 230 cadets who had entered during the last four years, and which is 1,679mm, as may be seen on table No. 2.

Annual growth tables, to be of value as standards of comparison, should be published from all the schools and colleges in all parts of the country, and the standards calculated for each year or fraction of each year during the entire period of growth. This, I hope may soon be done, for there is no lack of material on hand now to work them out.

WEIGHTS.

In the adjoining two tables of the weights the same division of the 50 cadets is presented, and carried out according to the same principle as was done in the two tables of heights, namely, 25 on each table, Table A of the weights presenting the records of the same cadets as Table A of the heights, and Table B of the weights presenting the records of the same cadets as Table B of the heights.

Table of weights.

A.

No.	Ages.	Weight (first examination).	Weight (second examination).	Gain.	No.	Ages.	Weight (first examination).	Weight (second examination).	Gain.
	Ys. Mo.	*Kilo.*	*Kilo.*	*Kilo.*		*Ys. Mo*	*Kilo.*	*Kilo.*	*Kilo.*
1	16 0	50.0	51.0	1.0	15	16 7	70.0	70	0.0
2	16 8	56.0	57.4	1.4	16	20 3	52.0	52	0.0
3	17 3	57.3	60.0	2.7	17	19 3	59.0	59	0.0
4	18 0	57.5	61.4	3.9	18	18 8	66.8	70.5	3.7
5	17 6	59.7	65.0	5.3	19	19 0	59.5	61.5	2.0
6	18 5	65.5	69.5	4.0	20	19 0	64.5	71.3	1.8
7	19 6	68.7	71.5	2.8	21	17 3	48.0	48	0.0
8	19 9	53.8	57.5	3.7	22	17 5	70.0	75	5.0
9	17 0	62.0	67.5	5.5	23	17 5	52.0	56	4.0
10	18 2	53.5	57.5	4.0	24	18 0	50.5	54	3.5
11	20 1	69.5	69.5	0.0	25	16 1	57.0	57	0.0
12	15 3	51.5	58.0	6.5					
13	17 1	60.0	62.9	2.9	Averages	18	59.1	61.7	2.6
14	18 9	58.0	61.2	3.2					

B.

No.	Ages.	Weight (first examination).	Weight (second examination).	Gain.	No.	Ages.	Weight (first examination).	Weight (second examination).	Gain.
1	19 11	69.0	71.1	2.1	15	18 5	72.5	78.0	5.5
2	16 0	58.0	59.7	1.7	16	18 7	57.5	62.5	5.0
3	16 6	69.5	74.2	4.7	17	19 3	59.0	62.5	3.5
4	17 9	62.0	63.7	1.7	18	19 8	63.5	65.9	2.4
5	19 2	64.7	67.7	3.0	19	19 5	62.5	67.0	4.5
6	18 2	51.0	52.8	1.8	20	15 5	50.5	53.5	3.0
7	17 3	61.5	61.9	0.4	21	18 11	53.5	57.5	4.0
8	18 4	55.0	60.5	5.5	22	17 9	60.5	65.5	5.0
9	18 0	60.0	60.5	0.5	23	16 3	57.7	64.2	6.5
10	19 0	66.5	72.3	5.8	24	16 4	52.5	59.0	6.5
11	19 0	67.0	75.0	8.0	25	19 7	71.0	75.2	4.2
12	17 8	70.6	75.3	4.7					
13	16 7	53 0	56.0	3.0	Averages	18	60.9	64.9	3.9
14	16 3	56.9	61.8	4.9					

On looking at the averages of these two tables, it will be noticed that Table A gives 1.8 of a kilogram less than Table B at the start, and that this difference between the two tables grows still greater at the second measurement, when it is found to be 3.2 kilograms. The average increase of the first 25 cadets is 2.6 kilograms, and the average increase of the second 25 is 3.9 kilograms, or 1.3 kilogram more. Both averages added together give for the entire number of cadets an average of 60 kilograms at the time of the first measurements and 63.3 kilograms for the second measurement, amounting to a semiannual increase in weight of 3.3 kilograms.

From the observations recorded in the paper by Prof. W. T. Porter, of St. Louis, it would appear that precocious individuals are taller as well as heavier,

and, furthermore, that the difference in weight between dull and precocious boys grows greater as they grow older.

Since, then, the first 25 cadets, as we have seen so far, are smaller, lighter, and less strong than the second 25, I have examined their examination marks, in order to see how Porter's results are borne out here, although our number is not very large. On adding up all their marks and dividing the sum by 25, those of Table A give 57, and those of Table B give 59 as the average, apparently confirming Porter's observations.

On turning to Seaver's tables of Yale students I find the average weight given for 18 years to be 55.4 kilograms and the weight for students of 18 years and 6 months to be 57.6, while the Amherst tables give 61 kilograms for the 18-year-old student. The weights of the cadets, therefore, would seem to be higher than those of Yale students and about the same as those of the students at Amherst.

So far, then, we have found not only that the members of Table B were taller, heavier, and stronger at the start than the members of Table A, but also that the increase in these qualities was greater as time went on, and in spite of the conditions being identical.

LUNG CAPACITY.

On looking at the two adjoining tables of the lung capacity we will find, although the average lung capacity on Table B is greater than that on Table A at the start, the average increase is about 20 cubic centimeters less on Table B than on Table A. The average lung capacity of the 50 cadets at the first measurement is 4,038, and at the second it is 4,192. This would amount to a semiannual average increase of 154 cubic centimeters.

Table of lung capacities.

A.

No.	Ages.	Lung capacity (first measurement).	Lung capacity (second measurement).	Gain.	No.	Ages.	Lung capacity (first measurement).	Lung capacity (second measurement).	Gain.
	ys. mo.	*cb. cm.*	*cb. cm.*	*cb. cm.*		*ys. mo.*	*cb. cm.*	*cb. cm.*	*cb. cm.*
1	16 0	3,605	3,768	165	15	16 7	4,669	4,915	246
2	16 8	3,683	3.768	85	16	20 3	3,441	3,849	408
3	17 3	3,522	3,605	85	17	19 3	4,096	4,096	0
4	18 0	3,441	3.605	164	18	18 8	4,424	4,588	164
5	17 6	3,932	4,096	164	19	19 0	3,768	3,932	164
6	18 5	4,669	4,915	246	20	19 0	5,408	5,408	0
7	19 6	5,244	5,408	164	21	17 3	3,605	3,686	81
8	19 9	3,683	3,768	85	22	17 5	4,915	4,915	0
9	17 0	4,096	4,505	409	23	17 5	4,424	4,583	164
10	18 2	3,605	3,768	163	24	18 0	3,683	3,768	85
11	20 1	3,768	3,768	0	25	16 1	3,683	3,932	....
12	15 3	3,605	3,932	327					
13	17 1	3,441	4.096	655	Average	18 0	4,007	4,184	177
14	18 9	3,768	3,932	164					

B.

No.	Ages.	Lung capacity (first examination).	Lung capacity (second examination).	Gain.	Loss.	No.	Ages.	Lung capacity (first examination).	Lung capacity (second examination).	Gain.	Loss.
	ys. mo.	*cb. cm.*	*cb. cm.*	*cb. cm.*	*cb. cm.*		*ys. mo.*	*cb. cm.*	*cb. cm.*	*cb. cm.*	*cb. cm.*
1	19 11	3,932	4,260	228	......	15	18 5	5,736	5,736	......	......
2	16 0	3,522	3,768	246	......	16	18 7	3,605	3,932	327	......
3	16 6	4,424	4,588	164	......	17	19 3	3,932	4,096	164	......
4	17 9	3,277	3,768	494	....	18	19 8	4,177	4,260	83	......
5	19 2	4,013	4,090	77	......	19	19 5	4,505	4,588	83	......
6	18 2	3,441	3,605	164	......	20	15 5	3,277	3,441	164	......
7	17 3	3,932	4,096	164	......	21	18 11	3,932	4,096	164	......
8	18 4	4,096	3,768	......	328	22	17 9	4,260	4,096	......	164
9	18 0	3,441	3,277	......	164	23	16 3	4,260	4,260	......	......
10	19 0	4,752	4,752	......	......	24	16 4	3,605	3,768	163	......
11	19 0	5,324	5,572	248	......	25	19 7	4,341	4,752	411	......
12	17 8	4,096	4,096	......	......						
13	16 7	4,260	4,260	......	......	Average	18 0	4,070	4,201	157	26
14	16 3	3,605	4,096	491	......						

It remains to be added that the lung capacities were taken by means of a dry spirometer registering cubic inches, which, for the sake of uniformity, were afterwards converted into cubic centimeters.

There is, perhaps, no one single subject in connection with physical training upon which more stress should be laid than the necessity of developing the lung capacity. The capability of drawing a sufficient amount of oxygen into the system to supply at all times and under all conditions and circumstances the necessary quantity for the full performance of the functions of every living cell in that system must ever be looked upon as a condition of the utmost importance. It is one of the principal aims of the physical educator. On the other hand, the reserve materials, not being regularly oxydized, would gradually accumulate and their presence in excess in the economy lead in the end to the most serious disturbances of health through autointoxication.

Now, the quantity of air introduced into the system at each inspiration being naturally regulated by the capacity of the lungs, it is of great importance that the conditions under which muscular work is capable of increasing the extent of that capacity should be thoroughly understood.

According to Lagrange, too much importance has been attached to the development of the muscles that elevate the ribs, and I am sure that the same mistaken idea prevails in this country with regard to the influence on chest capacity to be derived from the use of the popular chest-weights.

According to the same author, Demény's conclusions to the effect that more air enters the chest in the attitudes in which the scapulæ are drawn back and fixed by the tonicity and contractions of the rhomboidii, trapezii, and latissimi dorsi-muscles, the belly retracted by the aspiration of the viscera into the thorax than during repose, are entirely wrong. In this condition we find that all the inspiratory muscles except the diaphragm are in a state of forced contraction; the diaphragm alone remains in the position of expiration; and yet this is exactly the condition in which we find ourselves in the so-called position of attention so much insisted upon by the instructors of infantry tactics. The truth of this matter is that whatever is gained in lung capacity by the elevation of the ribs is lost by the ascent of the diaphragm, and therefore, as an exercise for increasing the lung capacity, the maneuver is absolutely without value. A similar, if not identical, condition of things prevails during exercises on the various chest weights. If, on the other hand, we take a very deep inspiration, we find that we are able not only to raise our ribs to the greatest possible limit, but we also find that the diaphragm, which is the largest and most powerful inspiratory muscle, will share in the movement and will push the abdominal viscera downward instead of allowing them to be sucked up into the chest, thus materially enlarging the chest capacity. The vertical diameter of the thorax is increased in this manner, while in the other condition it was diminished by visceral aspiration. In the opinion of Lagrange, with which we are in perfect accord, the most ingenious gymnastic combinations are not as efficient in increasing the intra-thoracic space as are deep inspirations, alternating with profound expirations, made during repose.

It is, therefore, not only of no advantage to increase the thickness of the thoracic walls and the muscles covering them, but it forms a direct obstacle to the normal and more natural method of enlarging the intra-thoracic space from within. It is from within outwards that the force capable of expanding the chest must act, and it is to the lungs themselves and not to the muscles that the chief share in the changes in form and size of the chest belongs. The most powerful inspiratory muscles can not raise the ribs unless the lungs themselves participate in the movement of expansion, as everyone can find out on himself; on the other hand, the lungs *can* raise the ribs without the aid of the muscles, for the chests of emphysematous people remain vaulted in spite of their efforts to lower the ribs and complete the expiratory movement. In order, then, to enlarge the capacity of the lung, it is clear that we must not attempt to act directly on the muscles that are attached to the chest, but we must prescribe exercises calculated to produce the most extensive respiratory movements, or in other words, such as produce the greatest respiratory need, and this is a large amount of muscular work done within a short space of timo including carefully graded running.

The results which wo have attained with tho fifty cadets so far as their increase in lung capacity is concerned, while not absolutely poor, are far from being satisfactory to us, and this point will be again referred to under "Vital Index."

In the accompanying Table III and Chart I are exhibited the results of some observations on eighteen cadets of an average age of 19 years and 3 months, on whom the above detailed principles were carried out as far as possible. The special exercises in these cases consisted principally in free movements without apparatus and a carefully graded. progressive running in the open air on a properly constructed running track. They were, in the first place, taught how to breathe properly, how to carry themselves during running, and a point more especially impressed upon their minds was never to run beyond the time when they became fatigued. No fixed period of time was set, because their endurance could very naturally increase but gradually, and must vary daily owing to outside influences over which we have no control. After a very short time and while strictly following this injunction of never passing the point of fatigue, they all were soon able to run a mile without fatigue, and some very much exceeded that distance, their general health and strength having at the same time very materially increased and improved.

TABLE III.—*Influence of one month's special exercise on lung capacity of eighteen cadets, average age 19 years and 3 months, average height 1,721^{mm}. Observations in April, 1892.*

No.	Lung capacity, first examination.		Lung capacity, second examination.		Gains.	
	Cubic centimeter.	Cubic inches.	cubic centimeters.	Cubic inches.	Cubic centimeters.	Cubic inches.
1	4,260	260	4,424	270	163	10
2	5,244	320	5,408	330	163	10
3	4,915	300	5,078	310	163	10
4	3,768	230	3,932	240	163	10
5	4,915	300	5,078	310	163	10
6	4,505	275	4,752	290	245	15
7	5,244	320	5,489	335	245	15
8	3,441	210	3,686	225	245	15
9	3,441	210	3,768	230	327	20
10	3,768	230	4,096	250	327	20
11	4,505	275	4,915	300	407	25
12	3,678	230	4,260	260	491	30
13	3,849	235	4,424	270	573	35
14	5,244	320	5,900	360	655	40
15	4,424	270	5,078	310	655	40
16	3,605	220	3,605	220	----------	----------
17	5,325	325	5,325	325	----------	----------
18	4,915	300	4,915	300	----------	----------
Average	4,352	265	4,683	286	331	20

The table and chart show that at the end of one month an average increase of 331 cubic centimeters, or 20 cubic inches, was observed, which amount is twice that observed in the fifty cadets at the end of six months, gymnastic work.

During running nearly all of the muscles of the human body are actively engaged, some more, some less. A large amount of venous blood is poured into the right side of the heart and through the lungs; an immense thirst for oxygen causes the deepest inspirations, which give rise to an increased lung capacity, provided heavy exercises, engaging the muscles that cover and surround the chest, tending to compress it from without, are not taken.

It was said above that besides running, a large amount of muscular work done within a short space of time, was one of the means of increasing the lung capacity. With regard to this point, I thought it interesting to ascertain what influence on the lung capacity of the players was produced by the popular game of football. The football season at Annapolis begins after October 1, and on October 15 I examined seventeen players who were the most likely to continue playing throughout the season. The same players were again examined on November 21, and I must confess my surprise was great when they nearly all came back with the same lung capacities. The only increase in the lung capacity that had taken place was noted in two half-backs, just the ones who had to do most of the running. Whether the results of my observations would have been different if I had been able to make my first examination on October 1, instead

of the 15th, or not, I am of course unable to say; but these observations have gone far to convince me of the fact that if there is any influence in football-playing on the lung capacities of the players, that influence must be exerted early in the beginning of the period of training, for after the chest is loaded down with strong, hard muscles, it must become almost impossible for the chest capacity to enlarge to any perceptible extent.

Now, while from a physiological point of view it is perfectly possible and intelligible by the proper exercise to increase the respiratory efficiency of a certain limited area of lung surface without even increasing the capacity of the lung itself, it might, nevertheless, be deemed good advice to attend to the lung capacity according to the best principles before attempting to play the game of football in real earnest. At any rate, as long as the exchange of gases in the lung is simply a physical process depending upon the difference in partial pressure between the CO_2 contained in the blood on one side of the respiratory macuous membrane and the O of the inhaled air on the other side of this same membrane, the amount of oxygen taken in and of CO_2 given out must be looked upon as being in direct proportion to the total capacity of the lung as ascertained by the spirometer.

TOTAL STRENGTH.

For the purpose of ascertaining and noting any changes that may have taken place in any individual human being after having had a course of physical training in the gymnasium or elsewhere, it is absolutely necessary that we should have several very thorough tests and established standards of sufficient scientific accuracy easily applied and uniformly accepted and followed, by means of which progress in certain directions can be definitely ascertained and the results compared. Among those that have so far been recommended the total-strength test is a most valuable one. When I first began to work with it, I must confess I had little confidence in its value, but further experience has caused me to look upon it as a most important and significant index.

It was for the purpose of still further testing the value of this index that the fifty cadets in question were divided in accordance with the amount of increase in total strength that had taken place during their six months' training in the gymnasium. On looking at the table indicating their total strength I took 100 kilograms as the dividing line, placing those whose increase was less than that on one side, and those whose increase exceeded that limit on the other, and found that they were quite equally distributed, namely, twenty-five on either side; and, so far as we have gone, we have found the average height, weight, and lung capacity much in favor of those whose increase in total strength was above 100 kilograms, a very significant factor even if the number of individuals under observation here is not over large. Physiological truths do not require in all cases an overwhelmingly large number of individuals to establish them, but a smaller number will suffice than would be necessary for the establishment of the average length of the human femur or the thickness of the thigh.

How is this total strength of an individual calculated? The exact amount of work done by our muscles in complicated cases of labor is by no means easily determined, and in fact has not been determined except in a few special cases. It is well known that during muscular work of any kind, certain substances are used up, the quantity depending upon the amount of work done, for the law of the conservation of energy holds true in the organic as well as in the inorganic world. The amount of work done in these cases is generally expressed in kilogrammeters, 1 kilogrammeter indicating the amount of work necessary to lift 1 kilogram, 1 meter, or 1 gram 1,000 meters, etc. Thus, the amount of work performed in walking is usually calculated, according to Rubner, by the following formula: 0.071 x k p in which formula 0.071 is the product of the height of lift and fall in each step, k, the body weight, and p, the number of steps taken.

From the amount of work thus attained, it is, on the other hand, easily calculated how much albumen, carbohydrate or fat was used, because the caloric equivalent of work has been found to be 425 kilogrammeters for 1 caloric and the number of calorics produced by burning certain definite quantities of these substances being also known.

But this method merely tells us the amount of energy that is necessary to be expended in certain kinds of special exercise or work; which, furthermore, may be distributed over a longer or shorter space of time. In making serial observations on a large number of individuals we wish more particularly to ascertain the total amount of available energy or strength which any of them may bring to bear upon an obstacle at any given moment. To calculate this the following rough and ready method has been devised:

According to the Anthropometric Manual of Amherst College, published in 1889 by Drs. E. Hitchcock and H. H. Seelye, the tests to be taken of an individual whose total strength is to to be calculated, are as follows:

1. *Expiratory strength.*—The subject, after loosening the clothing about the chest and filling the lungs, should blow with one blast into the manometer, an instrument made to register the expiratory pressure in kilos and tenths of kilos. Care should be taken that no air escapes at the sides of the mouth, and that in expelling the air all the muscles of expiration are brought into play.

2. *Strength of back.*—The subject standing on the iron foot rest with the dynamometer so arranged that when grasping the handle with both hands, his body will be inclined forward at an angle of 60 degrees, should take a full breath and without bending the knees give one hard lift mostly with the back.

3. *Strength of legs.*—The subject while standing on the foot rest with body and head erect, and chest thrown forward, should sink by bending the knees, until the handle grasped rests against the thighs, then taking a full breath he should lift hard, principally with his legs, using the hands to keep the handle in place over the thighs. (See Fig 1.)

4. *Strength of upper arms—triceps.*—The subject while holding the position of rest upon the parallel bars, supporting his weight with arms straight, should let the body down until the chin is level with the bars, and then push it up again until the arms are fullly extended. Note the number of times he can lift himself in this manner. (See Fig 2.)

5. *Strength of upper arms—biceps.*—The subject should grasp a horizontal bar or pair of rings and hang with the feet clear from the floor while the arms are extended. Note the number of times that he can haul the body up until his chin touches the bar or rings. (Fig 3.)

6. *Strength of forearms.*—The subject while holding the dynamometer (Fig. 4) so that the dial is turned inwards, should squeeze the spring as hard as possible, first with the right and then with the left hand. The number of kilograms may be read off from the dial and noted.

Total strength.—From the above data the total individual strength is caculated as follows: The body weight is multiplied by the sum of the dip and pull; this is divided by 10 to prevent too large a number of figures in the calculation. To this is added the strength of back, the strength of legs, the average of the forearm, and the lung strength, and the result is looked upon as the total strength. For example, the weight of the subject being 64, the dip 11, and the pull 12=23; the back strength 150, and the leg strength 180, the forearm strength 45, and the lungs 2.0, the result will be $64 \times 23 \div 10 + 150 + 180 + 45 + 2 = 524$.

Just why the strength of the muscles of the upper part of the body was not originally included in this test is now difficult to make out. The strength of both the chest muscles and those that extend between the spinous processes and the shoulder plate can easily be ascertained by one and the same instrument. These are actually given in the New Manual for Physical Measurements, by Dr. Luther Gulick, whose excellently illustrated manual should be in the hands of everyone taking such measurements.

For the sake of uniformity of records we have, however, adhered to the original formula, and our tables have all been calculated in accordance with it, so as to make them comparable with those ascertained by all who are taking such tests elsewhere. This strength test is not devoid of all scientific accuracy, but possesses a certain definite physiological value. If we take, for instance, the gastrocnemius of a frog and pass an induction shock through it, we get a contraction, whether we stimulate directly or indirectly. If we attach certain weights to one end of the muscle and increase them gradually and stimulate, there comes a time when our stimulus is no longer answered by a contraction of the muscle, and the weight attached to it will no longer be lifted, although the stimulus passes through the muscle, as is indicated by the galvanometer. In this condition, in other words, we have arrived at the weight which exactly counterbalances the absolute power of the muscle under observation.

In the above-described strength test we have, undoubtedly, an analogous condition of things. The number of kilograms which we can lift with our backs and legs being the exact amount necessary to counterbalance the strength of those muscles that are engaged in pulling; in other words, indicating their absolute strength just the same as the absolute power is represented by weight in the experiment with the frog's gastrocnemius.

The muscular contraction produced by the stimulus of the will may perhaps not be a maximal contraction and the curve produced in the case may not be anything like the curve produced by a single induction shock, but resemble more

nearly a tetanic curve, still the amount of strength that these tests require us to exert at the time represent the greatest possible amount which we are capable of exerting at any one time, and which is here expressed in kilograms, just the same as the absolute power is represented in weight in the experiment with the frog's gastrocnemius.

Total strength table.

A.

No.	Age.	Total strength. First examination.	Total strength. Second examination.	Gain.	No.	Age.	Total strength. First examination.	Total strength. Second examination.	Gain.
	Ys. Mo.	*Kilo.*	*Kilo.*	*Kilo.*		*Ys. Mo.*	*Kilo.*	*Kilo.*	*Kilo.*
1	16 0	304	343	39	15	16 7	592	629	37
2	16 8	410	462	52	16	20 3	423	519	96
3	17 3	348	410	62	17	19 3	272	369	97
4	18 0	369	438	69	18	18 8	470	538	68
5	17 6	444	522	78	19	19 0	375	408	33
6	18 5	447	513	66	20	19 0	525	596	71
7	19 6	411	452	41	21	17 3	357	440	83
8	19 9	428	517	89	22	17 5	510	557	47
9	17 0	312	394	82	23	17 5	390	452	62
10	18 2	339	381	42	24	18 0	392	419	27
11	20 1	431	484	53	25	16 1	289	340	51
12	15 3	355	390	35					
13	17 1	310	400	90	Averages	18 0	390	467	77
14	18 9	549	611	62					

B.

No.	Age.	Total strength. First examination.	Total strength. Second examination.	Gain.	No.	Age.	Total strength. First examination.	Total strength. Second examination.	Gain.
1	19 11	441	604	163	15	18 5	423	539	116
2	16 0	338	494	106	16	18 7	434	552	118
3	16 6	459	640	181	17	19 3	315	498	183
4	17 9	309	430	121	18	19 8	392	804	412
5	19 2	561	824	263	19	19 5	312	498	186
6	18 2	322	432	110	20	15 5	326	512	186
7	17 3	428	608	180	21	18 11	230	463	233
8	18 4	300	412	112	22	17 9	410	542	132
9	18 0	270	389	119	23	16 3	356	519	163
10	19 0	446	579	133	24	16 4	302	425	123
11	19 0	560	672	112	25	19 9	450	575	125
12	17 8	443	812	369					
13	16 7	359	495	136	Averages.	18 0	380	550	170
14	16 5	304	520	216					

TABLE IV.—*Influence of one month's special exercise on total strength of eighteen cadets; average age, 19 years 3 months; average height, 1721mm. Observation made in April, 1892.*

No.	Total strength. First examination.	Total strength. Second examination.	Gain.	No.	Total strength. First examination.	Total strength. Second examination.	Gain.
	mm.	*mm.*	*mm.*		*mm.*	*mm.*	*mm.*
1	498	547	49	11	724	853	129
2	376	436	60	12	419	552	133
3	538	604	66	13	374	514	140
4	674	744	70	14	504	647	143
5	647	717	70	15	621	785	164
6	474	558	84	16	626	824	198
7	431	521	90	17	498	491	(*)
8	476	568	92	18	559	495	(†)
9	438	536	98				
10	573	702	129	Averages	524	636	112

* Loss 7. † Loss (sickness) 71.

On examining the two total strength tables we find that they average as follows: The 50 cadets on their entrance examination developed an average total strength of 385 kilos, and at their second examination, or about six months

later, the average total strength was 508½, showing a gain of 123½ kilos, which is the highest average gain ever noted at the academy between the first and second examinations. Furthermore, when we compare their average strength with that of Amherst students of the same age we find that the cadets on entering were 35 kilos behind the Amherst students, whose average strength at 18 years, and which is our average age, is given by Hitchcock as 420 kilos; but after the second examination, and comparing its results with those obtained from the same students even at 19 years of age, we find that the cadets are 50 kilos ahead of the Amherst students, whose average strength at that age is given as 448 kilos, while that of the cadets is 508½ kilos, which is about 20 per cent above the average total strength obtained from 2,230 of the Amherst students.

Looking at Table A and comparing the average with those of Table B, we find that the average increase of the first twenty-five is 77 kilos, while that of the second twenty-five is 170 kilos, although the former were 10 kilos ahead of the latter at the first examination. In order to increase one's total strength, however, especially while young and still in the growing period of life, we do not always require very many months to do it. A month or six weeks well directed exercise may add from 25 to 30 per cent of that strength, as is well shown in Table No. IV.

Table IV presents the same cadets, as regards total strength, as Table III of the lung capacity, the two observations being made, in other words, on the same cadets at the same time. It is seen that after such a short time as one month's specially directed exercise, which was very light indeed, and beginning with an average of 524 kilos, an average increase of 112 kilos=636 kilos had been obtained.

TABLE V.—*Influence of one month's practice at football on total strength of seventeen players, average age, 19 years and 6 months; average height 1,765 mm.*

No.	Total strength. First examination.	Total strength. Second examination.	Gain.	No.	Total strength. First examination.	Total strength. Second examination.	Gain.
	mm.	*mm.*	*mm.*		*mm.*	*mm.*	*mm.*
1	648	689	41	11	500	612	112
2	758	801	43	12	852	974	122
3	654	703	49	13	500	630	130
4	621	672	51	14	501	635	131
5	648	700	52	15	664	836	172
6	746	832	86	16	692	884	192
7	521	608	87	17	626	824	196
8	692	790	98				
9	543	649	106	Average	642	747	105
10	753	860	107				

Here, although the average increase does amount only to 103 kilos, it must be remembered that the initial average strength of the 17 cadets measured was 644 kilos, and at the end of five weeks' football practice it amounted to 747, with a maximum of 974 and a minimum of 612. Assuming, as we must, that there exists a natural individual limit to development in strength, the increase must become slower the nearer we approach that limit, just the same as growth in height becomes slower from year to year as we approach the final limit of our intended height.

VITAL CAPACITY.

The term "vital capacity," as employed in connection with the usual anthropometric records, appears to me somewhat misleading, inasmuch as it implies in its meaning a certain physiological significance which it does not possess. The name vital capacity was originally used by Hutchinson to denote the respiratory capacity of an individual, and which is usually measured by a modified gasometer (spirometer of Hutchinson), into which the subject breathes, making the most prolonged expiration possible after the deepest possible inspiration. The quantity of air which is thus expelled from the lungs is indicated by the height to which the air chamber of the spirometer rises, and by means of a scale placed in connection with this, the number of cubic centimeters is read off.

The vital capacity as recorded on anthropometric charts in use in our gymnasiums is obtained by different methods, namely: (1) Seaver (Anthropometry) arrives at it by multiplying the length of trunk, depth of chest and breadth of chest together; the result is the vital capacity. (2) Gulick (Manual for Physical Measurements) states ' that the vital capacity refers to the size of the trunk," but "does not represent the cubical size of the body, although it varies in a general way with it." He calculates it by multiplying the length of the trunk by the average between the depth of the chest and the depth of the abdomen, this again being multiplied by the average between the width of the chest and the width of the waist. Just what this so-called vital capacity is intended to represent does not appear to be very clearly defined in the descriptions of the methods for obtaining it. If, as Dr. Gulick states, it does not represent the cubical size of the body, what does it represent? It certainly appears to have little, if any, definite physiological significance, so far as a man's chances for life are concerned, for these can simply not be measured in this manner, and if not, why should we continue to apply the term vital capacity to what is in reality nothing but the capacity of the trunk?

In the following two tables of vital capacities calculated according to Gulick's method, it will be noticed that the losses on both exceed the gains, and we now must ask ourselves how this result has come about. Let us take the example of a boy 18 years of age, just entering college and taking a course in the gymnasium for the first time in his life. He is measured in the usual manner, presents a well developed chest, padded with a goodly layer of adipose tissue, and a well-rounded abdomen. At the end of the academic year, and after working well in the gymnasium, he is measured again and it is found that he has grown taller, weighs more, is very considerably stronger, and has a greater lung capacity than the year before, but his adipose tissue has almost entirely disappeared and his abdominal walls have become more muscular; consequently his abdomen less rotund; having, furthermore, also increased the strength of his respiratory muscles, he is able to contract his chest better, and the result of both these changes will be that he has lost in vital capacity, much to his chagrin, and it certainly would be most disheartening for him to be told that he had grown taller, heavier, and stronger at the expense of his vital capacity. On the other hand, a man 40 years of age, the age when in most persons the stomach obtains its final triumph over the chest and permanently establishes its supremacy over the latter, so far as prominence is concerned, will, on being similarly measured, give a greater vital capacity than he did at the age of 25 or 30 years of age, when perhaps his physical condition was at its best and his chances for life greatest.

I should accordingly propose the term "capacity of the trunk" in place of "vital capacity," as ascertained by the methods above detailed.

The average vital capacity of the fifty cadets at the first measurement, as shown by these tables, was 3,152$^{\text{mm}}$ and on the second measurement it was 3,085$^{\text{mm}}$ or 67 less. Since the anthropometric tables so far published by either Hitchcock of Amherst, or Seaver of Yale, do not include the vital capacity, it is of course impossible to make a comparison.

Table of vital capacities.

A.

No.	Age.	Vital capacity, first examination.	Vital capacity, second examination.	Gain.	Loss.
	ys. mo.	*mm.*	*mm.*	*mm.*	*mm.*
1	16 0	2,261	2,745	484	......
2	16 8	3,205	2,999	......	206
3	17 3	3,307	2,750	......	557
4	18 0	2,441	3,016	575	......
5	17 6	3,003	2,925	......	78
6	18 5	3,570	3,620	50	......
7	19 6	3,751	3,556	......	195
8	19 9	2,770	2,306	......	464
9	17 0	3,276	3,096	......	180
10	18 2	2,737	2,799	62	......
11	20 1	3,081	3,100	19	......
12	15 3	2,841	2,496	......	345
13	17 1	3,197	3,197	......	......
14	18 9	2,391	2,295	......	96
15	16 7	3,828	3,381	......	447
16	20 3	2,940	2,727	......	213
17	19 3	3,009	2,967	......	42
18	18 8	3,427	3,856	429	......
19	19 0	2,925	3,513	588	......
20	19 0	3,978	3,853	......	125
21	17 3	2,432	2,449	17	......
22	17 5	3,446	3,718	272	......
23	17 5	2,546	2,714	168	......
24	18 0	2,964	2,828	......	136
25	16 1	2,940	2,589	......	351
Averages	18 0	3,051	3,020	107	137

Table of vital capacities—Continued.

B.

No.	Age.	Vital capacity, first examination.	Vital capacity, second examination.	Gain.	Loss.	No.	Age.	Vital capacity, first examination.	Vital capacity, second examination.	Gain.	Loss.
	ys. mo.	*mm.*	*mm.*	*mm.*	*mm.*		*ys. mo.*	*mm.*	*mm.*	*mm.*	*mm.*
1	19 11	4,133	3,243	------	890	15	18 5	4,132	3,978	------	154
2	16 0	2,673	2,916	243	------	16	18 7	3,762	3,924	162	------
3	16 6	3,576	3,531	------	45	17	19 3	3,321	3,063	------	258
4	17 9	3,233	3,078	------	155	18	19 8	3,042	3,132	90	------
5	19 2	3,126	3,407	281	------	19	19 5	3,367	3,276	------	91
6	18 2	3,304	2,590	------	714	20	19 5	3,044	2,436	------	608
7	17 3	3,258	2,898	------	360	21	18 11	2,867	2,541	------	326
8	18 4	3,276	3,180	------	96	22	17 9	3,078	3,495	417	------
9	18 0	3,092	2,582	------	510	23	16 3	2,883	2,740	------	143
10	19 0	3,616	3,362	------	254	24	16 4	2,451	2,782	331	------
11	19 0	3,399	3,752	353	------	25	19 7	3,565	3,488	------	77
12	17 8	3,056	3,469	413	------						
13	16 7	3,226	3,113	------	113	Averages	18 0	3,252	3,150	92	196
14	16 3	2 827	2,727	------	100						

VITAL INDEX.

Under the above name Enebuske (*loc. cit.*) has introduced the *ratio of lung capacity and weight* of Demény. This index appears to me to be of considerable physiological significance in connection with the subject of physical training and the study of its results. From the physiological point of view the introduction into scientific physical training of valuable and significant indices, such as the above, is as much of a necessity and of as great importance now as was the introduction of weights and measures into chemistry a hundred years ago.

The original papers of Demény are not accessible to me, but Dr. Enebuske states that Demény has found that in children of the same age the lung capacity is proportional to their weight, and that if a curve is constructed of lung capacity and weight in function of age, the two curves are parallel. Demény has furthermore found that the ratio of lung capacity and weight of persons who have undergone a course of systematic physical training is much higher than in persons who have had no such training, from the fact familiar to us all, that the training on the one hand increases the lung capacity, and, on the other, diminishes at least in the beginning the weight, by causing a great quantity of the reserve tissue (fat) to disappear.

In the adjoining two tables of vital indices I have applied this index to the 50 cadets under observation. It will be noticed, however, that but 16 out of 50 have gained, 31 have lost, and 3 have remained the same. The average vital index obtained from both tables together at the first examination was 0.0679, at the second examination 0.0667, amounting to an average loss of 0.0012. It will furthermore be noticed that for the first time, so far as we have gone in our comparative study of these two tables, the first table presents higher averages than the second table. It was found, in other words, that the 25 cadets whose increase in total strength was 100 or more kilos, and who are always represented by Table B were taller, heavier, stronger and had a greater average lung capacity than the 25 whose increase in total strength had been found to be less than 100 kilos, and who are always represented by Table A. In the tables of the vital indices we meet with the first exception to this. An average decrease in vital index of 0.0012 may not be very great, but it is certainly appreciable, and must have a cause, for I firmly believe in the validity and significance of this index. On referring to the tables of the lung capacities and taking Table B, it will be noticed that besides the average increase being smaller than in Table A, 5 out of the 25 have remained the same and 3 have actually lost in lung capacity. No matter how disheartening it may be to realize such results, the finding them out is as important and salutary as the obtaining of contrary results would be gratifying.

Table of vital indices.

A.

No.	Age.	First examination.	Second examination.	Gain.	Loss.	No.	Age.	First examination.	Second examination.	Gain.	Loss.
1	16 0	0.0721	0.0740	0.0019	....	15	16 7	0.0671	0.0702	0.0031	....
2	16 8	0.0659	0.0656	....	0.0003	16	20 3	0.0661	0.0741	0.0080	....
3	17 3	0.0614	0.0601	....	0.0013	17	19 3	0.0691	0.0694	....	....
4	18 0	0.0598	0.0587	....	0.0011	18	18 8	0.0662	0.0650	....	0.0012
5	17 6	0.0558	0.0630	....	0.0028	19	19 0	0.0633	0.0639	0.0006	....
6	18 5	0.0786	0.0707	....	0.0079	20	19 0	0.0779	0.0758	....	0.0021
7	19 6	0.0763	0.0756	....	0.0007	21	17 3	0.0749	0.0769	0.0020	....
8	19 8	0.0684	0.0655	....	0.0029	22	17 5	0.0702	0.0656	....	0.0046
9	17 0	0.0660	0.0667	0.0007	....	23	17 5	0.0851	0.0819	....	0.0032
10	18 2	0.0674	0.0655	....	0.0019	24	18 0	0.0729	0.0698	....	0.0031
11	20 1	0.0542	0.0542	....	....	25	16 1	0.0646	0.0689	0.0043	....
12	15 3	0.0700	0.0676	....	0.0024						
13	17 1	0.0573	0.0651	0.0078	....	Average	....	0.0692	0.0688	0.0011	0.0015
14	18 9	0.0650	0.0643	....	0.0007						

B.

No.	Age.	First examination.	Second examination.	Gain.	Loss.	No.	Age.	First examination.	Second examination.	Gain.	Loss.
1	19 11	0.0570	0.0600	0.0030	....	15	18 5	0.0791	0.0735	....	0.0056
2	16 0	0.0594	0.0603	0.0009	....	16	18 7	0.0626	0.0629	0.0003	....
3	16 6	0.0636	0.0618	....	0.0018	17	19 3	0.0666	0.0655	....	0.0011
4	17 9	0.0528	0.0591	0.0063	....	18	19 8	0.0646	0.0646	....	....
5	19 2	0.0609	0.0605	....	0.0004	19	19 5	0.0709	0.0684	....	0.0025
6	18 2	0.0675	0.0683	0.0008	....	20	15 5	0.0649	0.0624	....	0.0025
7	17 3	0.0639	0.0662	0.0023	....	21	18 11	0.0735	0.0712	....	0.0023
8	18 4	0.0745	0.0623	....	0.0122	22	17 9	0.0704	0.0625	....	0.0079
9	18 0	0.0573	0.0542	....	0.0031	23	16 3	0.0777	0.0663	....	0.0114
10	19 0	0.0715	0.0657	....	0.0058	24	16 4	0.0586	0.0638	....	0.0048
11	19 0	0.0784	0.0743	....	0.0041	25	19 7	0.0601	0.0632	0.0031	....
12	17 8	0.0580	0.0544	....	0.0036						
13	16 7	0.0800	0.0761	....	0.0039	Average	18 0	0.0667	0.0646	0.0003	0.0030
14	16 3	0.0634	0.0663	0.0029	....						

I have for some little time past been dissatisfied with the progress that the cadets have made in breathing capacity, consequently, this last year in superintending the exercises, special stress was laid on the importance of breathing exercises on chest-weights, and special attention was paid to carefully graded running; and I am as firmly convinced that the instruction and drill which the cadets have received in the gymnasium was as well calculated to develop their lung capacities as any that could be devised as I am that the vital index is true and not misleading. What, then, is the cause of the decrease in vital index? I believe it due to the snug-fitting uniforms worn by the cadets of this school, and which they are obliged to wear the greater part of the day. Although this seems to me quite a reasonable explanation, this fact can only be established by the study of and comparison with the statistics of other military schools.

When, however, we compare an average of vital index of the 50 cadets, obtained at the second examination, and which is 0.0667, and find that it is above the average of the 50 per cent Yale student and only below the average vital index of 113 Swedish navy recruits (aged 19), we have, as yet, no great cause for being alarmed, but are, on the contrary, very much encouraged.

It is, futhermore, obvious that any increase in weight, from no matter what cause, may in a few instances cause considerable lowering of the vital index. This would make it appear certain that a high vital index would be in most cases a sure indication of perfect training, whether it is noticed in children, women, or men. In a large number of scholars doing a certain amount of exercise, especially after the first few months, I have frequently noticed a considerable increase in weight as a direct result of the exercise, and, as will be noticed on referring to the tables of weights, this average increase in the cases of the 50 cadets is over 3 kilos. Even admitting that a man in perfect training must have a high vital index, the object is not invariably attained in all cases, and more often requires special attention and training.

Our average is higher than that given by Demény of methodically trained Frenchmen aged 22, and which is 0.0615.

As regards the meaning of this index, Dr. Enebuske says: "If we are compelled to translate this index into popular language, we could not come nearer the truth than to say that it means power of resistance during the emergencies of disease,* and that it expresses an essential and fundamental condition for endurance under effort. It does not represent the moral or nerve-dynamic elements of endurance, but it represents a chemico-dynamic component of endurance." Demény (quoted by Enebuske) makes this statement:

"By taking young gymnasts and arranging them according to the decreasing value of their rates of lung capacity and weight, we have been able to ascertain that thereby we have made a classification that corresponds sensibly to their degree of resistance."

In practicing gymnastics Enebuske has observed a marked correspondence between the vital index and ability in such exercises in which the weight of the body is carried by the arms or thrown from the ground by forcible contractions of the muscles of the legs, as jumping and vaulting. Taking perpendicular rope-climbing as an example, he found that 6 out of the 26 students examined by him could not climb the rope and that their V. I. was below 0.0478; the remaining 20, whose V. I. was above 0.0478, could all climb, except one.

Owing to the fact that the publication of Dr. Enebuske's paper was much delayed, I regret that I was unable this year to test his conclusions in this direction; but this much is certain, namely, that for endurance there is nothing more essential from a physiological point of view than a large lung capacity.

THE POWER INDEX.

This index is the V. I. multiplied by the total strength of the individual. The average power index of the 50 cadets at the first examination was 26.23, and at the second examination it had increased to 33.38, making a difference of 7.15 between the two examinations. Looking over the Amherst table of the 50 per cent student and calculating from the data given there, we get a power index of 28.5843 for the average Amherst student. The power indices of the fifty cadets under consideration are shown in the following tables:

TABLE A.

No.	Age.	Power Index— $Po = T S \frac{L C}{W}$			No.	Age.	Power index— $Po = T S \frac{L C}{W}$		
		First examination.	Second examination.	Gain.			First examination.	Second examination.	Gain.
	ys. mo.					*ys. mo.*			
1	16 0	21.88	26.75	4.87	15	16 7	39.66	44.03	4.37
2	16 8	24.56	30.03	5.47	16	20 3	27.91	38.40	10.49
3	17 3	21.22	24.66	3.44	17	19 3	17.95	29.35	6.40
4	18 0	21.77	25.84	4.07	18	18 8	31.02	34.97	3.95
5	17 6	28.41	32.88	4.47	19	19 0	23.62	26.11	2.49
6	18 5	31.73	36.42	4.69	20	19 0	40.95	44.70	3.75
7	19 6	31.64	38.77	7.13	21	17 3	26.77	33.88	7.11
8	19 9	29.53	33.60	4.07	22	17 5	35.70	36.20	0.50
9	17 0	20.59	26.22	5.63	23	17 5	33.15	37.06	3.91
10	18 2	22.71	24.76	2.05	24	18 0	28.61	29.33	0.72
11	20 1	23.27	26.13	2.86	25	16 1	18.49	23.12	4.63
12	15 3	24.85	26.52	1.67					
13	17 1	17.67	26.00	8.33	Averages	18 0	27.17	31.62	4.44
14	18 9	35.68	39.71	4.03					

*As to whether we are entitled to this assertion or not, experience in other directions than that of mere gymnastics must prove how this could be brought into harmony with our present understanding of infectious diseases. Comparisons must be made at the bedside. I know of at least one instance which would not bear out this assertion. A gentleman prominent in foot-ball, in excellent condition, whom I measured only three weeks before his death, and whose vital index was 0.0782, died of typhoid fever in the surprisingly short time of a week.

TABLE B.

No.	Age.	Power index— Po=TS $\frac{LC}{W}$ First examination.	Second examination.	Gain.	No.	Age.	Power index— Po=TS $\frac{LC}{W}$ First examination.	Second examination.	Gain.
	ys. mo.					*ys. mo.*			
1	19 11	25.13	36.24	11.11	15	18 5	33.45	39.61	6.16
2	16 0	20.07	26.18	6.11	16	18 7	27.16	34.70	7.54
3	16 6	29.19	39.55	10.36	17	19 3	20.97	32.61	11.64
4	17 9	16.31	25.41	9.10	18	19 8	25.31	51.93	26.62
5	19 2	34.10	49.85	15.75	19	19 5	22.11	34.06	11.95
6	18 2	21.73	29.49	7.76	20	15 5	21.15	31.94	10.79
7	17 3	27.34	40.24	12.90	21	18 11	16.90	32.96	16.06
8	18 4	22.35	25.66	3.31	22	17 9	28.86	33.87	5.01
9	18 0	15.47	21.07	5.60	23	16 3	27.66	34.40	7.74
10	19 0	31.88	38.03	6.15	24	16 4	20.71	27.11	6.40
11	19 0	43.90	49.92	6.02	25	19 7	27.04	36.34	9.30
12	17 8	25.69	44.17	18.48					
13	16 7	28.72	37.66	8.94	Averages	18 0	25.30	35.14	9.84
14	16 3	19.27	34.47	15.20					

STRENGTH-WEIGHT INDEX, AND VITAL STRENGTH-WEIGHT INDEX.

For the sake of future reference and comparison, I append also the tables of these two indices. The strength-weight index is expressed by the formula $\frac{T.S.}{W.}$ and the vital strength-weight index by that of V. I.$\frac{T.S.}{W.}$ The results are recorded in the tables.

TABLE A.

First observation. No.	$\left(\frac{T.S.}{W.}\right)$	$\left(V.I.\frac{T.S.}{W.}\right)$	Second observation. No.	$\left(\frac{T.S.}{W.}\right)$	$\left(V.I.\frac{T.S.}{W.}\right)$
1	6.1	0.4392	1	6.6	0.5148
2	7.3	0.4745	2	8.0	0.5200
3	6.1	0.3721	3	6.8	0.4080
4	6.3	0.3717	4	7.1	0.4189
5	7.4	0.4736	5	8.0	0.5040
6	6.8	0.4828	6	7.4	0.5254
7	5.9	0.4543	7	6.3	0.4725
8	7.9	0.5451	8	9.0	0.5850
9	5.0	0.3300	9	5.8	0.3828
10	6.3	0.4221	10	6.6	0.4290
11	6.2	0.3348	11	7.0	0.3780
12	6.7	0.4690	12	6.7	0.4556
13	5.0	0.2750	13	6.3	0.4095
14	9.4	0.6110	14	10.0	0.6500
15	8.5	0.5695	15	9.0	0.6300
16	8.1	0.5346	16	10.0	0.7400
17	4.6	0.3086	17	6.2	0.4092
18	7.0	0.4620	18	7.7	0.5005
19	6.2	0.3906	19	6.7	0.4288
20	7.5	0.4850	20	8.4	0.6100
21	7.4	0.5550	21	9.1	0.7007
22	7.3	0.5110	22	7.4	0.4810
23	7.5	0.6175	23	8.0	0.6560
24	7.8	0.5694	24	7.8	0.5460
25	5.0	0.3200	25	6.0	0.4080
Averages	6.5	0.4355	Averages	7.5	0.5052

TABLE B.

First observation.			Second observation.		
No.	$\left(\frac{T.S.}{W.}\right)$	$\left(V.I.\frac{T.S.}{W.}\right)$	No.	$\left(\frac{T.S.}{W.}\right)$	$\left(V.I.\frac{T.S.}{W.}\right)$
1	6.4	0.3648	1	8.5	0.5100
2	5.8	0.3445	2	8.2	0.4944
3	6.6	0.4197	3	8.8	0.5438
4	5.0	0.2640	4	7.0	0.4137
5	8.7	0.7298	5	12.2	0.7381
6	6.3	0.4252	6	8.2	0.5600
7	6.9	0.4409	7	9.8	0.6487
8	5.4	0.4023	8	6.8	0.4236
9	4.5	0.2578	9	6.5	0.3523
10	6.7	0.4790	10	8.0	0.5256
11	8.3	0.6307	11	9.0	0.6687
12	6.3	0.3654	12	10.8	0.5875
13	6.8	0.5440	13	8.8	0.6696
14	5.1	0.3233	14	8.4	0.5569
15	5.8	0.4587	15	6.9	0.5071
16	7.6	0.4757	16	8.8	0.5535
17	5.3	0.3529	17	8.0	0.5240
18	6.2	0.4005	18	12.2	0.7881
19	5.0	0.3545	19	7.4	0.5161
20	6.4	0.4153	20	9.5	0.5920
21	4.3	0.3160	21	8.0	0.5696
22	6.8	0.4787	22	8.9	0.5562
23	6.2	0.4817	23	8.1	0.5354
24	5.7	0.3010	24	7.2	0.4593
25	6.3	0.3786	25	7.6	0.4803
Averages	5.4	0.3601	Averages	8.5	0.5491

HEART RATE.

The Association Gymnasium record blanks direct that the heart rate should be ascertained before and immediately after the strength tests. Experience has shown that a weak heart beats fast very readily, even on slight exertion, while a strong one does not do so. The principle is perhaps best illustrated by the following table, which belongs to an officer 28 years of age, and who for about a year devoted himself most conscientiously to systematic training:

Number of examinations.	July 4.	Oct. 7.	Dec. 16.	Jan. 4.	May 3.
Pulse 1	100	92	88	88	72
Dip	1	3	6	13	14
Pull	5	11	12	13	12
Back	155	150	170	200	180
Legs	280	310	320	270	325
Forearm	35	45	43	46	40
Strength of lung	25	25	25	20	20
Weight	66.5	61.5	62.5	64	64.5
Pulse 2	160	134	120	104	110
Total strength	511	593	647	686	714

In this diagram we notice a steady decrease in the number of heart beats, not only as regards the initial pulse rate (pulse 1), but also in the rate recorded after the strength test had been taken. This is as it should be.

There is, then, no doubt that a strong and vigorous heart is one of the results of systematized exercise, but this result is attained not only by the greatest possible care and attention to details on the part of the director of such exercise, but also by the most conscientious coöperation on the part of the person taking the exercise. In my experience this result is exceptional in pupils that are exercised in classes and without receiving individual and special care and attention. The more we study the subject of physical training, the more also the individual differences and personal peculiarities of mankind become apparent. There are a number of qualities that are no less real because they can not be weighed and measured.

In the fifty cadets under observation the greatest differences with regard to the pulse rate have been observed. Some present a greater initial pulse rate at their second than they did at their first examination, and in some, even, the

pulse rate after taking the strength tests was higher at the second examination than it was at the first; in some no change has taken place, and in still others marked improvement has been recorded.

By practicing certain forms of exercises we no doubt become able to dominate over certain actions not ordinarily under the control of the will. We learn to regulate the working of our lungs, thus also influencing the heart rate, but it is almost impossible for any one, no matter how well trained he may be, to do his best at these strength tests without at the same time increasing his heart rate to some extent. Indeed, one of the first effects of exercise of any kind is to increase the frequency of the heart beat, as we all know, and consequently to quicken the blood current. No one has ever seen a person doing the "dip" or the "pull" without noticing that the skin over the working muscles becomes red and congested, owing to the increased amount of blood flowing not only to the working muscles, but also to the periphery.

On making so great an effort in so short a time as these strength tests require, one being taken right after the other, and owing to the large amount of blood which is sent to the periphery in consequence, it is, perhaps, quite natural to find the arterial pressure fall and the pulse rate quicken.

I have myself not been able, owing to an absence of proper instruments, to make accurate and conclusive experiments in regard to blood pressure, but the accompanying sphygmograms would go far to show that the existence of a lowered blood pressure after this strength test is probable in a majority of cases. Nothing, however, short of accurate pressure tests will decide this most interesting point.

Oertel (Handbuch d. Therapie d. Kreislaufs störungen), 1891, in a very painstaking series of experiments, has conclusively shown that the blood pressure rises somewhat on prolonged walking and mountain climbing, also that there is an increased pulse rate. Both these changes in the circulation produced by this form of exercise persists for some time, even after the feeling of fatigue has quite passed away, which latter point has also been observed by Lagrange (*loc. cit.*).

Our results, however, are not comparable to those of Oertel. The curves which we present (see Plates I and II) were taken immediately after a severe effort was made, and before anything like a thorough equalization of venous and arterial circulation could have taken place. The fall in arterial pressure in a sudden effort may be due to the fact that more blood is suddenly thrown into the veins than is returned into the left side of the heart, and also to the incomplete oxygenation of the blood, which must have a depressing effect on the heart itself.

Oertel's blood-pressure tests were made hours after the start, consequently long after the balance between venous and arterial circulation had been restored, and the exercise taking place in the open air, the blood after a long walk or climb was in a much improved condition, in so far as oxygenation is concerned, and hence the rise in blood pressure.

The accompanying diagram and Table VI, however, show that well-regulated exercise strengthens the heart so that it may resist, as it were, the sudden invasion of effort to a certain extent:

TABLE VI.

Number.	Increase in heart rate before taking exercise.		Increase in heart rate after one month's exercise.	
1	70	80	62	72
2	78	92	66	88
3	90	110	88	108
4	80	110	76	92
5	96	112	72	72
6	92	120	72	96
7	92	120	80	96
8	100	124	72	80
9	92	124	84	92
10	92	130	72	100
11	100	140	92	120
12	100	140	84	104
13	92	140	80	92
14	92	140	80	100
Averages	90	120	84	101
Average rate of increase	30		17	

NOTE.—The figures and diagrams referred to in the text of this paper have been necessarily omitted in the publication.

See over page

April 1: The patient continues to do well. Morning temperature, 99.2°; respiration, 24; pulse, 108. Evening temperature, 99.8°; respiration, 24; pulse, 102. Very little membrane visible; tonsils and pharynx almost normal in appearance. There is difficulty in getting patient to take nourishment. She can swallow only 1 or 2 drachms at a time, and no longer retains nutrient enemata. However, she does not lose strength.

April 2: Nine a. m., temperature, 98.4°; respiration, 27; pulse, 106. Passed a good night. At 1.30 p. m. Dr. Richardson removed the tube—just seventy-two hours after its introduction. She continued to breathe without any difficulty whatever. No membrane was visible anywhere in the fauces, and it was evident that there was no remaining laryngeal obstruction. As soon as the tube was removed she expressed a desire for food, and at the end of four hours was able to swallow fluid food as well as ever. Evening temperature, 9 p. m., 98°; pulse, 80; respiration, 24.

April 3: Slept all night except when wakened for nourishment. This morning temperature fell to 96.4°, pulse to 54. Skin became cool and clammy. Administered extra brandy and ordered $\frac{1}{40}$ grain of strychnia three times a day.

April 17: During past two weeks patient has steadily improved and is now able to run about and play, but is still restricted to same room. Appetite good. For two or three days after removal of tube she still spoke in a whisper, but the voice gradually returned, and at the end of ten days was natural. For ten days there was a subnormal temperature and pulse, with sweat every night from about midnight to early morning. This symptom has now disappeared. A culture has been taken every five days, but the Klebs-Loeffler bacillus is still reported as present.

An examination of urine, April 4, showed a trace of albumen but no casts. On March 31 the older brother, aged 8, and younger sister, aged 2, were immunized with Behring's No. 1. Nothing resulted in the case of the boy. Six days after the injection an erythematous area of 4 inches diameter appeared on the little girl where the needle had been introduced. Two days later this had disappeared, but a papular eruption of measles appeared and she is now convalescent from a characteristic attack of this disease. This shows that antitoxine has no effect upon measles. Both the other children have had the disease. A papular eruption also developed in the diphtheria patient on the eighth day after the first injection of antitoxine. It was scattered irregularly over the body, but caused the patient no inconvenience. It subsided within forty-eight hours.

May 1: Culture taken to-day. Bacilli of diphtheria still present.

CASE II.

April 1, 1895: Was called to see B. R., female, aged 12 years. Patient had been sick about five days, complaining of soreness in throat. White patches had been noticed on both tonsils, but as patient had been subject to attacks of follicular tonsillitis, her trouble was at first supposed to be of this nature. During past two days patient had seemed weaker. I found several distinct patches of membrane on right tonsil; nothing abnormal on left tonsil. She was pale, with cool skin; pulse, 110, feeble and somewhat irregular; appetite poor; voice husky, but no difficulty of respiration; occasional hacking cough. Believing the disease to be diphtheria, I obtained a culture tube and

made an inoculation. I gave contents of bottle of Behring's antitoxine No. 2 at once (1 p. m.), without waiting for report from culture. Prescribed brandy every two hours; tinct. ferri chlorid. in glycerin every two hours; throat to be sprayed with Seiler's solution every hour.

April 2: Report from culture shows presence of Klebs-Loeffler bacillus. Appearance of tonsil the same, and patient's general condition unchanged, except that she has completely lost her voice and speaks only in a whisper; no glandular enlargement; cough continues. At 3 p. m., twenty-six hours after first injection, patient was given a second injection of Behring's No. 2.

April 3: Improving. Voice returning. Membrane on right tonsil commencing to come away. Continued brandy and tincture of iron, with Seiler's spray.

April 4: Membrane almost gone. Voice natural; no cough. Patient better and stronger in every way. Urine examined and found normal.

April 5: Membrane all gone. Appearance of throat normal. From this time patient made an uninterrupted recovery.

A culture taken April 6 showed Klebs-Loeffler bacillus and streptococci. A subsequent culture April 12 contained no bacilli of diphtheria. On April 2 six other members of the family, three adults and three children, received each an injection of one-third of a bottle of Behring's No. 1. No other cases of diphtheria developed in the family, though all had been more or less exposed.

NORMAL GROWTH UNDER THE INFLUENCE OF EXERCISE.

By HENRY G. BEYER, *Surgeon, United States Navy.*

In the two reports on normal growth, etc., which were forwarded in 1893 and 1894, respectively, and published in the Report of the Surgeon-General to the Secretary of the Navy for that year, it was shown that those of the cadets whose total strength had increased over 100 kilos during six months' regular exercise in the gymnasium were on the average also taller and heavier than those whose total strength showed an increase below 100 kilos. This is again shown in the tables that form the basis of the present and third report. We may therefore take it as pretty well proven that, cæteris paribus, the taller and heavier a boy is the greater are his chances for an increase in total strength to be derived from any system of regular and systematized gymnastic exercise.

Instead of dividing each table into A and B, as was done in former reports, it was thought more advantageous to present all the increases in the various dimensions in one table. The first thirty-eight numbers in each table in this report correspond to Table A, and the last twenty to Table B of former reports, respectively, and just as was the case in former reports so do also here the numbers of one table refer to the same individuals on every other table. Thus, No. 15 on the table of heights refers to the same person that is represented by the same number on the table of the weights, etc. This is done for the purpose of facilitating future work in connection with all the tables so far published. The ages are given in years and months and are averaged as such for the reason that it is deemed more accurate to do so than it is to reckon from either the last or nearest birthday whenever we are dealing with small numbers and with intervals of less than one year.

It must, furthermore, be kept in mind when looking over these tables that all the increases in the different dimensions here presented are not annual, but only semiannual, increases.

TABLE 1.—INCREASE IN HEIGHT IN MILLIMETERS.

No.	Age.	First examination.	Second examination.	Gain.	Loss.	No.	Age.	First examination.	Second examination.	Gain.	Loss.
1	15.7	1,606	1,640	34	......	31	17.7	1,690	1,706	16	......
2	18.2	1,710	1,722	12	......	32	18	1,718	1,740	22	......
3	17.11	1,658	1.670	12	......	33	18.8	1,665	1,672	7	......
4	17.3	1,750	1,764	14	......	34	19.1	1,860	1,860	0	......
5	17 10	1,580	1,595	15	......	35	18.8	1,710	1,710	0	......
6	17.10	1,690	1,690	0	......	36	17.11	1,766	1,772	6	......
7	18.7	1,658	1,660	2	......	37	19.9	1,700	1,700	0	......
8	19.9	1,780	1,780	0	......	38	17.7	1,754	1,758	4	......
9	18.2	1,750	1,756	6	......	39	19	1.645	1,655	10	......
10	18.4	1,816	1,820	4	......	40	17.9	1,722	1,720	......	2
11	17.11	1,705	1,710	5	......	41	18.10	1,778	1,790	12	......
12	18.5	1,663	1,665	2	......	42	19.9	1,560	1,569	9	......
13	20.4	1,770	1,780	10	......	43	18	1,624	1,635	11	......
14	18.11	1,746	1,750	4	......	44	19.1	1,778	1,778	0	......
15	19	1,677	1,681	4	......	45	17.8	1,746	1,750	4	......
16	18.7	1,698	1,705	7	......	46	16.6	1,583	1,590	7	......
17	17.6	1,728	1,743	15	......	47	16.1	1,755	1,785	30	......
18	15.6	1,712	1,732	20	......	48	16.11	1,643	1,652	9	......
19	17.7	1,671	1,685	14	......	49	17.1	1,782	1,785	3	......
20	15.7	1,653	1,663	10	......	50	18	1,706	1,706	0	......
21	16.8	1,710	1,710	0	.....	51	18	1,730	1,732	2	......
22	17.7	1,700	1,710	10	......	52	19	1,680	1,690	10	......
23	19.10	1,755	1,765	10	......	53	19.5	1,743	1,745	2	......
24	19	1,805	1,805	0	......	54	18.6	1,840	1,846	6	......
25	17.10	1,680	1,685	5	......	55	17.11	1,592	1,592	0	......
26	18.6	1,684	1,700	16	......	56	15.11	1,744	1,765	21	......
27	15	1,658	1,680	22	......	57	17.9	1,802	1,810	8	......
28	19.3	1,710	1,710	0	......	58	16.9	1,709	1,709	0	......
29	16.5	1,630	1,645	15	......						
30	18.8	1,715	1,720	5	......	Average	17.10	1,709	1,717	8	......

TABLE 2.—INCREASE IN WEIGHT IN KILOS.

No.	Age.	First examination.	Second examination.	Gain.	Loss.	No.	Age.	First examination.	Second examination.	Gain.	Loss.
1	15.7	45	50.5	5.5	......	31	17.7	54	60	6	......
2	18.2	51	59.5	8.5	......	32	18	58	64.5	6.5	......
3	17.11	53	54	1	......	33	18.8	56	59	3	......
4	17.3	57	60.5	3.5	......	34	19.1	81	86	5	......
5	17.10	50	58	8	......	35	18.8	66	66	0	......
6	17.10	62	61	......	1	36	17.11	65	66	1	......
7	18.7	56	57	1	......	37	19.9	63	65.5	2.5	......
8	19.9	63	68	5	......	38	17.7	73	73	0	......
9	18.2	67	72	5	......	39	19	58	61	3	......
10	18.4	78	82	4	......	40	17.9	63	64	1	......
11	17.11	54	61	7	......	41	18.10	66	69	3	......
12	18.5	62	65	3	......	42	19.9	51	53.5	2.5	......
13	20.4	71	74	3	......	43	18	62	62	0	......
14	18.11	65	69	4	......	44	19.1	72	75	3	......
15	19	61	69.5	8.5	......	45	17.8	61	66	5	......
16	18.7	65	63	......	2	46	16.6	48	54	6	......
17	17.6	55	62	7	......	47	16.1	63	68	5	......
18	15.6	60	65	5	......	48	16.11	57	65	8	......
19	17.7	47	55	8	......	49	17.1	55	59.5	4.5	......
20	15.7	46	50	4	......	50	18	68	68	0	......
21	16.8	67	68.5	1.5	......	51	18	59	64.5	5.5	......
22	17.7	56	58.5	2.5	......	52	19	56	60.5	4.5	......
23	19.10	60	65	5	......	53	19.5	67	66	......	1
24	19	66	67	1	......	54	18.6	72	76	4	......
25	17.10	54	55	1	......	55	17.11	57	57	0	......
26	18.6	59	64	5	......	56	15.11	66	69	4	......
27	15	50	54	4	......	57	17.9	73	75	2	......
28	19.3	70	70	0	......	58	16.9	72	73	1	......
29	16.5	50	53	3	......						
30	18.8	61	62.5	1.5	......	Average	17.10	60.7	64	3.3	......

TABLE 3.—INCREASE IN LUNG CAPACITY IN CUBIC INCHES.

No.	Age.	First examination.	Second examination.	Gain.	Loss.	No.	Age.	First examination.	Second examination.	Gain.	Loss.
1	15.7	200	210	10	......	31	17.7	190	200	10	......
2	18.2	250	270	20	......	32	18	250	250	0	......
3	17.11	210	225	15	......	33	18.8	250	265	15	......
4	17.3	250	270	20	......	34	19.1	370	370	0	......
5	17.10	210	220	10	......	35	18.8	210	270	60	......
6	17.10	200	220	20	......	36	17.11	270	285	15	......
7	18.7	200	210	10	......	37	19.9	200	220	20	......
8	19.9	220	250	30	......	38	17.7	280	280	0	......
9	18.2	230	260	30	......	39	19	240	250	10	......
10	18.4	310	310	0	......	40	17.9	270	285	15	......
11	17.11	230	240	10	......	41	18.10	250	260	10	......
12	18.5	270	280	10	......	42	19.9	220	220	0	......
13	20.4	230	240	10	......	43	18	220	225	5	......
14	18.11	250	275	25	......	44	19.1	255	260	5	......
15	19	260	300	40	......	45	17.8	270	300	30	......
16	18.7	250	250	0	......	46	16.6	170	190	20	......
17	17.6	220	240	20	......	47	16.1	280	305	25	......
18	15.6	250	285	35	......	48	16.11	220	220	0	......
19	17.7	220	230	10	......	49	17.1	220	220	0	......
20	15.7	190	210	20	......	50	18	260	260	0	......
21	16.8	270	270	0	......	51	18	260	270	10	......
22	17.7	260	260	0	......	52	19	240	260	20	......
23	19.10	260	275	15	......	53	19.5	250	290	40	......
24	19	280	290	10	......	54	18.6	220	280	60	......
25	17.10	190	200	10	......	55	17.11	220	225	5	......
26	18.6	180	200	20	......	56	15.11	260	250	......	10
27	15	190	230	40	......	57	17.9	280	280	0	......
28	19.3	260	260	0	......	58	16.9	290	305	15	......
29	16.5	180	220	40	......						
30	18.8	220	240	20	......	Average	17.10	239	254	15	......

TABLE 4.—INCREASE IN TOTAL STRENGTH IN KILOS.

No.	Age.	First examination.	Second examination.	Gain.	No.	Age.	First examination.	Second examination.	Gain.
1	15.7	239	505	266	31	17.7	307	431	124
2	18.2	270	343	232	32	18	509	631	122
3	17.11	378	603	225	33	18.8	460	573	113
4	17.3	414	638	224	34	19.1	571	680	109
5	17.10	435	644	209	35	18.8	366	471	105
6	17.10	437	646	209	36	17.11	461	565	104
7	18.7	485	679	194	37	19.9	373	476	103
8	19.9	463	656	193	38	17.7	694	797	103
9	18.2	513	705	192	39	19	482	580	98
10	18.4	628	793	165	40	17.9	603	691	88
11	17.11	424	583	159	41	18.10	532	618	86
12	18.5	583	741	158	42	19.9	402	487	85
13	20.4	404	561	157	43	18	450	533	83
14	18.11	413	565	152	44	19.1	605	687	82
15	19	508	655	147	45	17.8	497	572	75
16	18.7	456	601	145	46	16.6	323	394	71
17	17.6	426	571	145	47	16.1	482	552	70
18	15.6	456	599	143	48	16.11	468	537	69
19	17.7	357	497	140	49	17.1	375	436	61
20	15.7	310	450	140	50	18	428	487	59
21	16.8	464	602	138	51	18	608	666	58
22	17.7	430	568	138	52	19	469	525	56
23	19.10	299	436	137	53	19.5	532	584	52
24	19	592	729	137	54	18.6	456	481	25
25	17.10	395	531	136	55	17.11	525	547	22
26	18.6	403	534	131	56	15.11	534	528	— 6
27	15	220	348	128	57	17.9	631	620	—11
28	19.3	623	751	128	58	16.9	826	754	—72
29	16.5	390	517	127					
30	18.8	421	545	124	Average	17.10	463	582	119

The following table (5) is to show the results of the observations of the preceding two years as compared with those of the present year:

TABLE 5.—AVERAGES OF SEMIANNUAL INCREASES IN HEIGHT, WEIGHT, LUNG CAPACITY, AND TOTAL STRENGTH FOR A PERIOD OF THREE YEARS.

Year.	Number of observations.	Average age.	Average height.			Average weight.			Average lung capacity.			Average total strength.		
			First examination.	Second examination.	Gain.	First examination.	Second examination.	Gain.	First examination.	Second examination.	Gain.	First examination.	Second examination.	Gain.
			Mm.	*Mm.*	*Mm.*	*Kilos.*	*Kilos.*	*Kilos.*	*C. in.*	*C. in.*	*C. in.*	*Kilos.*	*Kilos.*	*Kilos.*
1892–93	50	18	1,721	1,729	8	60	63.3	3.3	246	256	10	385	508	123
1893–94	74	18	1,709	1,722	13	58.5	62.6	4.1	242	260	18	422	528	106
1894–95	58	17.10	1,709	1,717	8	60.7	64	3.3	239	254	15	463	582	119
Averages	....	17.11	1,713	1,723	10	59.7	63.3	3.8	242	254	14	423	539	116

A rather noteworthy feature and very conspicuous in Table 5 is perhaps the closeness with which the averages in the various dimensions and their increases recur from year to year, and this notwithstanding the fact that the numbers of the observations of each year vary and are not very large. The differences are indeed but small, so far as height, weight, and lung capacity are concerned, and, therefore, all the more significant. The items considered under the head of total strength, as may be easily understood, are the more variable factors in the list. It is well known that a certain amount of strength may be gained as well as lost in a comparatively short space of time. It does not require a very long and accurate series of observations to show that exercise, taken on physiological principles and in strict accordance with the laws of health, produces a very prompt increase in total strength. It is, however, very different as regards the relation of exercise to the growth and development of the human body in other dimensions. Nothing short of a long-continued series of observations in weighing and measuring can possibly teach us anything definite with regard to these. Besides, before the influence of exercise on the growth of the human body in any and every dimension can be known, we must first of all ascertain what that growth would be under normal conditions and uninfluenced by such exercise. It is here that we meet with the greatest difficulty of our problem, and it may be stated with perfect fairness that the normal growth curve of the human subject is as yet unknown for any dimension. An attempt at constructing such a curve in several important dimensions has been made from measurements recorded of naval cadets for about thirty years past. These curves, published in No. 74 of the Proceedings of the United States Naval Institute, may well serve as a means for comparing with them the results obtained through exercise in the gymnasium. The difficulty of getting at the true state of affairs seems still further increased by the discovery made known in the same paper that growth in height, for example, is different for tall boys from what it is for small boys in the years covered by these observations. This having been demonstrated conclusively by a sufficiently large number of individual and continuous records covering a period of from 15 to 21 years of age, it follows that our average curves obtained from boys of all sizes may perhaps be applicable to certain types included in the whole number, but do not and can not

apply generally. A curve which is normal for a short boy would be decidedly abnormal for a tall one, and the average derived from the two would not fit either.

In the paper just referred to it was furthermore shown that tall boys have completed their development in height much earlier than short boys, that is to say, that short boys continue to grow longer and to a later age than do tall boys. In order, then, to arrive at results that are reliable and true, by a comparison of normal curves and curves influenced by exercise, we must take account of all these conditions on which growth depends naturally.

In another year the material at hand will be large enough for making a comparison with the normal growth curves in the various dimensions which have been under observation. The influence of gymnastic exercise on the development of the human body in these dimensions will then be accurately shown.

AID TO THE WOUNDED ON SHIPBOARD.

By AVERLY C. H. RUSSELL, *Passed Assistant Surgeon, United States Navy.*

On account of the limitations of this subject it seems to me impossible to avoid the repetition of opinions others have already advanced. I shall not seek excuses, therefore, for ideas in which I may have been anticipated by more competent writers; on the contrary, I acknowledge at once with pleasure my indebtedness for the suggestions of those I have been fortunate enough to consult. It is to be regretted that no details could be had as to the number of the killed and wounded on the Japanese ships in proportion to the crews in their recent engagements with the Chinese and as to the means employed to aid the injured. Such information would give an idea of the practical working of a system for the care of the wounded which, otherwise, must be largely speculative.

While the provisions of a hospital for use during action and the organization and working of a hospital corps are not the first considerations in the construction and equipment of men-of-war, their great importance can not be questioned. The difficulties of the subject have been increased by the complicated arrangements of modern ships. No system can approach perfection, and we must be content with an imperfect one; still, it is absolutely essential that some system be adopted, provided for, and regulated. The lot of the wounded will be terrible enough in the next naval war, and it will not be improved by insufficient and incompetent aids to the injured. On the other hand, proper preparation for the care of the wounded will not only serve the cause of common humanity but will also strengthen the moral force of the men and increase their confidence.

As to the medical service on shipboard in action, all naval surgeons agree on the necessity for, first, places of safety where the wounded can be received and taken care of; second, convenient means for transporting them, and, third, trained men to handle them. Here are some of the conclusions of different surgeons upon these points:

Medical Director Admiral J. D. McDonald, of the British navy, thinks that "the great diversity in the arrangements of modern warships precludes the adoption of definite rules as to the precise locality in which the wounded can be treated; as the space available under any circumstances will be not only limited but inaccessible from other points,